Light and Lighting

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CONTENTS

	Page
Editorial Notes	113
Notes and News ...	114
Servicing Fluorescent Lamp Installations ...	117
Human Factors in Industry	121
Foot-Candle Levels ...	123
Trotter Memorial Lecture	125
The Editor Replies ...	129

The Trotter Memorial Lecture

ON **page 125** readers will find an appeal on behalf of the **Trotter Memorial Lecture,** to be established in memory of Mr. Alexander Pelham Trotter, who was the oldest I.E.S. member and who occupied the Presidential Chair for several critical years when the Society was young and feeling its way.

It was an immense gain to the Society at that stage to have as its President such a distinguished scientist and engineer, responsible for much original pioneering work in illuminating engineering.

Such a lecture would serve as a fitting memorial of a great figure in the field of illuminating engineering and should add to the prestige of the Society.

Let all members, therefore, even those who had not the privilege of knowing Mr. Trotter, respond generously to this appeal. Their contributions will form the nucleus of a fund to be administered by the Society.

Illumination Notes and News

Lighting and Vision

Lighting and Vision—as has been emphasised frequently in contributions to this journal—are very closely associated. There are, however, too few experts who know both sides, and it is particularly desirable that those who are experts on eyesight problems should study illumination.

It is encouraging to note, therefore, that in his recent Presidential Address to the Ophthalmological Society of New Zealand, Dr. W. A. Fairclough (a recently joined I.E.S. member), selected as his subject "Industrial Lighting." In doing so he showed familiarity with many problems that are the daily concern of illuminating engineers, such as the various forms of glare. He also devoted considerable attention to the fluorescent lamp, dealing with it, however, mainly from the physical side. In the course of his address, a note on which appears elsewhere (see p. 122), Dr. Fairclough tilted against one or two familiar obsessions, such as the "light over the left shoulder" conception of lighting, and the fashionable habit of wearing dark glasses whenever the sun happens to shine. Such notions, however, are not confined to laymen. Experts—even illuminating engineers—have their pet fancies too.

Anything To Tell Us?

In our last issue (p. 92) we stressed the duty of I.E.S. members to make prompt response to the appeal for papers—especially if they were experts in some special field of knowledge or had practical knowledge of specialised lighting in some field of industry.

It has been suggested to us that this request might well be extended to include contributions to LIGHT AND LIGHTING. We gladly take the opportunity, therefore, to invite readers, and I.E.S. members in particular, to send in contributions of merit—and it may in some cases be easier to do this than to prepare a formal paper since limitations of space compel us to be brief. Articles varying in length from 1,000 to 2,000 words are most acceptable, though longer contributions are also welcome if the material justifies greater length.

The essential thing, however, is that it should contain "news or views" of definite interest, so that readers may feel they are gaining new information or are having their outlook widened and developed. There is no room to travel constantly over familiar ground.

Nottingham I.E.S. Centre News Letter

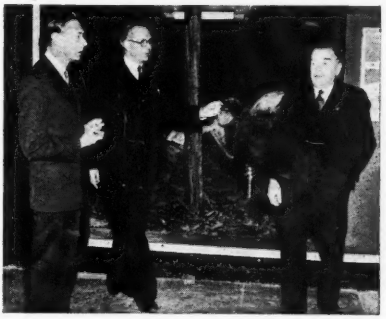
We are interested to see that the I.E.S. Nottingham Centre has recently fallen in with the practice of issuing occasional "news letters" to local members. No. 1 was issued in March, No. 2 covers the April-May period. Besides recording past events and announcing new ones the most recent letter contains some personal notes of interest. There is a brief contribution from Mr. C. S. Caunt recalling the formation of the Centre in 1939, an expression of condolence with the present chairman, Mr. J. C. Charity, who has, unluckily, been confined to his house through illness, and a reference to the activities of Mr. T. Walker, one of the founders of the Centre. He has recently gained fame in the bee-keeping world, having this year accepted the chairmanship of the "North-East Midlands Federation of the British Bee Keepers' Association." The summer outing, we note, is to be concluded by high tea or dinner at a hostelry in the region of Dovedale, and the annual meeting by a smoking concert at the Trent Bridge Inn—both evidently intended to be happy occasions.

A *Pocket Size "Calcu-Light-Or"*

This little apparatus, evolved by the Westinghouse Electric Corporation (Cleveland, U.S.A.) is announced in *Illuminating Engineering*. Approximately 4 in. by 8½ in. in size and of slide-rule design, it is stated to embody all the technical information necessary to make calculations either by the lumen or point-by-point methods. This seems to be a useful device. Although various aids, shortening calculations of illumination, have been devised in this country, nothing quite similar to this seems to have been made available here. Now Mr. Davey!

H.M. The King at the "Darkness into Daylight" Exhibition

In our last issue (May, 1948, p. 106) we referred to the "Darkness into Daylight" exhibition at the Science Museum, which was honoured by a visit from H.M. The King. We



have since received the two accompanying illustrations recording this event. In the upper picture Mr. L. J. Davies, Director of Research to the B.T.H. Company, is seen demonstrating the application of fluorescent lighting at the coal face to H.M. The King; Mr. George Tomlinson, Minister of

Education, is seen standing to the right of the picture. In the lower illustration a similar demonstration is being staged, the subject here being the blending of different colours to furnish the "daylight white" of fluorescent lamps.

Fluorescent Street Lighting

We are interested to note that the City of Westminster Works and Traffic Committee has reported favourably on the trial fluorescent lighting installation in Old Bond-street. The system, it is stated, has answered well under both wet and dry conditions and the installation is to become a permanent one, subject to the adoption of a slightly modified form of lantern. We mention elsewhere in this issue a fluorescent lighting scheme recently introduced in the streets of Wolverhampton, and there have been similar developments in the West of England. The latest instance that has been brought to our notice is the equipment in the Marylebone-road (London), where the new lighting should be specially acceptable at the busy Baker-street crossing.

I.E.S. Cardiff Centre

Annual Report

The annual report of the I.E.S. Cardiff Centre, which has recently reached us, contains a good record of solid work. Two items that call for special notice are the lectures to school children (on which we commented recently) and the initiation of a course on illuminating engineering at the Cardiff Technical College. Mr. S. G. Turner, who for so many years served as hon. secretary and hon. treasurer, is now the chairman-elect. During his period of office the Centre has acquired nearly 100 members, the only sad item recorded is the death, early in the present year, of Professor T. David Jones, by which both the Centre and the I.E.S. as a whole suffered a grievous loss.

I.E.S. Visit to a Colliery

On Tuesday, May 11, a group of I.E.S. members visited Chislet Colliery, near Canterbury. After lunch in Canterbury the party arrived at the colliery at 2 p.m., and was soon directed to the pit-head baths, for the all-important task of changing into suitable clothes for the journey underground.

The 450 yards descent to the main roadway was accomplished in just under 45 seconds, and then began the $1\frac{3}{4}$ mile journey to the coal face itself. The first 150 yards of the roadway was lighted by means of 5-foot fluorescent tubes, in specially designed, distributing type fittings, spaced at intervals of 30 feet. With the assistance of whitewashed walls and ceiling, the effect, as one member remarked, was reminiscent of Piccadilly Underground Station.

The fluorescent tubes gave way to tungsten filament lamps in well glass fittings, and then, after a further half-mile or so, with the exception of odd lamps at road junctions, the only light available was that provided by the hand lamps with which each member had been provided. At the coal face, twin 15-watt pneumatic electric fluorescent lamps were used in flame-proof fittings. The illumination provided was about 0.5 lumen per square foot, but, owing to the effect of long period of dark adaptation of the eyes on the journey to the coal face, this seemed very much more in practice.

A welcome, and very necessary return to the baths concluded a most enjoyable and instructive afternoon.

Servicing Fluorescent Lamp Installations

By W. A. R. STOYLE, B.Sc., A.M.I.E.E.

The following article is an extract from a paper on the operation and maintenance of fluorescent lamp installations which was presented to the Edinburgh Centre of the I.E.S. on November 21, 1947

The general servicing of a fluorescent lamp installation, whilst not so simple as that of a tungsten filament lamp installation, certainly presents no difficulties to the maintenance engineer. Minor faults in the circuit and control gear may sometimes give rise to trouble, and whilst such faults are rare, it is endeavoured, in this article, to chronicle most of the cases which might conceivably occur in practice.

With filament lamps, failure to light, assuming that the external circuit is in working order, is in almost all cases due to failure of the lamp filament, a fact easily ascertainable by visual inspection. In the case of fluorescent lamps, however, failure to light satisfactorily may be due to the tube itself or to some fault or mal-adjustment of the control gear. Generally speaking any such faults are extremely easy to trace and remedy.

A circuit which is not operating normally should be disconnected at once from the supply until the defect can be remedied, and, if a number of lamps are operating from the same main circuit switch, the lamp should be removed from the defective unit and this particular circuit locally isolated.

It is important to remember that a new lamp should never be tried on a circuit which has been operating in an abnormal manner until it has been established that the circuit itself is not faulty or until the original fault has been rectified.

Lamp and Auxiliary Gear Faults

Assuming that the external operating condition of mains voltage and ambient temperature are normal and within the specified tolerance, a lamp may (a) only attempt to strike, or (b) may not strike at all for various reasons associated with the lamp itself, with the control gear or with the circuit wiring. The possible sources of trouble in both cases are indicated in Table I.

Many of the factors in the above

TABLE 1

Lamp attempts to strike:—

(a) Lamp	(i)	Life expired.
	(ii)	Faulty lamp.
(b) Starter switch	(i)	Contacts break too quickly (glow or thermal type).
	(ii)	Low extinguishing voltage (glow type).
	(iii)	Incorrect voltage starter (glow type).
(c) Control gear	(i)	Incorrect choke or choke tapping.
	(ii)	Incorrect capacitor in T.L. circuit.
(d) Wiring	(i)	Heater coil and switch contacts of thermal type starter reversed.

Lamp will not strike:—

(a) Lamp	(i)	Broken electrode.
	(ii)	Cracked tube.
	(iii)	Faulty lamp.
(b) Starter switch	(i)	High striking voltage (glow type).
	(ii)	Broken bi-metal (glow or thermal type).
	(iii)	Cracked bulb.
	(iv)	Open circuit in heater coil (thermal type).
	(v)	Switch contacts will not close (thermal type)
	(vi)	Short circuited contacts (glow type).
(c) Control gear	(i)	Open circuited choke.
	(ii)	Open circuited capacitor (T.L. circuit).
(d) Wiring	(i)	Disconnection in wiring.
	(ii)	Lampholders or starters not making contact.
	(iii)	Incorrect wiring.

schedules of faults are obvious and need no explanation, but it is necessary to consider some of them in detail.

Lamps

Taking first of all the case of the lamp itself, cause of failure may be due to the fact that it has had its normal life. The active electrode coating is necessary for starting and maintaining the discharge through the lamp. When a lamp is nearing the end of its life, this electrode coating is practically exhausted, but the electrodes, still being electrically intact, complete the circuit through to the glow starting switch. The switch contacts, therefore, close and open again and the high voltage surge causes a momentary "blink" in the tube, but, due to the electrode coating being exhausted, the discharge through the lamp is not maintained. This cycle is then repeated by the glow switch and there is a periodic blinking in the lamp which is the general symptom of a tube nearing the end of its life. This blinking is usually accompanied by a shimmering effect in the discharge.

Further indications that a lamp is nearing the end of its life is the deep orange coloured glow of one or both electrodes or a dense blackening at one or both ends either in the form of general blackening or in the form of a clearly defined ring near the electrode.

Cracked tubes and broken electrodes should be obvious from visual inspection, but where the fluorescent coating comes very close to the lamp cap it may be necessary to test the electrode for continuity. If one electrode is broken a slight glow at this end of the lamp will be noted as the mains voltage will be applied through the starter switch across the broken ends. In this latter case there will be no measurable voltage across the starter switch contacts.

If the lamp is faulty from other than the above causes, it will probably try to start in a manner similar to a lamp which has had a normal life and whose electrode coating is exhausted.

Starting Switches—Glow Type

The satisfactory operation of the glow starting switch depends on its voltage and on the time characteristics, which must be controlled by the manufacturer within close limits. For example, if the "striking voltage" of a glow switch is too high, the switch contacts will not close and the lamp discharge will not start. If the "extinguishing voltage" of the switch is too low, the switch contacts will tend to close after the lamp discharge has started; this causes periodic blinking. Again, if the switch contacts, through some fault in the bimetallic strips, operate too quickly, the lamp electrodes may not have time to heat up before the switch contacts open again, producing repeated flashing and accelerated dissipation of the electrode coating. On the other hand if the switch contacts operate too slowly the lamp electrodes may be overloaded. It will be clear, therefore, that the "relative ease" of the start is important and a switch that does not start a good lamp in a few seconds should be replaced.

A normal switch will, however, outlive quite a number of lamps and whilst the life of a lamp is to some extent influenced by the total number of switchings throughout life, provided the switch has the correct characteristics the lamp may be switched many thousands of times before any substantial effect on performance is likely to be noticed.

If the switch contacts of the glow switch are locked together the lamp electrodes will, of course, glow continuously but the tube will not start. It must also be remembered that the rated starter voltage must be appropriate to the mains voltage concerned.

Starting Switches—Thermal Type

As in the case of the glow type switch the switch contacts must not break too quickly, so that the electrodes have sufficient time to become incandescent. Too rapid breaking will result in repeated attempts to start the lamp. Continuity of the heater coil is checked across the smaller pair of contacts of the canister type switch.

Chokes and Capacitors

Intermittent working or bad starting may be due to the wrong value of inductance or capacitance in series with the lamp. If the current through the lamp is too low, either through the incorrect choke or choke tapping being used, or the wrong value of capacitor, the voltage across the lamp will be abnormally high. This condition may

cause the switch contacts of the glow or thermal starter switches to close, extinguishing the lamp. The starting current will also be inadequate. The operating current and voltage should, therefore, be carefully measured in such a case.

An open circuited capacitor, in the case of the series pattern, will, of course, result in non-striking of the lamp, but if connected in parallel may not be obvious if the mains current is not measured. Capacitors should take about 45 milliamps per microfarad, and can easily be tested by connecting them across the mains with an appropriate meter in series.

Short circuit in chokes and capacitors can have more serious effects, as described later. A short circuit, or partial short in a choke, is best checked by connecting the doubtful choke in series with a similar choke across the mains and measuring the voltage drop across each choke. The normal short circuit current of a 40-watt choke should not exceed about 0.8 amps., and that of an 80-watt choke about 1.6 amps.

Wiring Faults

An earth fault in the wiring of a fluorescent fitting can cause complete destruction of one or both lamp electrodes, the starting switch, and also damage to the choke coil itself. The effect of this depends on the particular position of the earth on the circuit and the manner in which the phase and neutral leads are disposed. A lamp overloaded in this manner is generally quite obvious; the tube electrodes are blown off, the lead-in wires are fused, and the electrode coating volatilised on the inside of the lamp.

Owing to the fact that during the starting period momentary voltages of 800 to 1,000 volts are produced, breakdown may occur in the wiring or in the radio interference suppression capacitor if the insulation of these components is of poor quality or is defective.

If the choke coil is connected in the neutral lead of the supply, an earth fault on the wiring between the choke and the lamp electrode or between the lamp electrode and the glow starting switch, will clearly short circuit the choke, so that there is no limit to the current, and the lamp electrode and starting switch will be damaged or destroyed. On the other hand, if the choke is connected in the phase lead an earth fault will short circuit the choke across the mains, causing the choke to overheat, but as the choke is still limiting the current to the prescribed value the lamp electrodes will not be seriously damaged if the circuit is switched off quickly. It is clear, therefore, that less damage is likely to occur if the choke coil is connected in the phase lead of the supply. If it is suspected that the previous lamp failed through an overload, the fitting should be checked over for earth faults before a new lamp is installed.

In the capacitative branch of the T.L. circuit if the lamp is by mischance connected across the capacitor, catastrophic overloading will occur. This effort is also caused by connecting the ordinary parallel P.F. capacitor across the lamp instead of across the mains. Both these mis-connections result in a partially resonant circuit.

Premature Blackening of Lamp Ends

Excessive blackening at the ends of the lamp occurring abnormally early in life indicates that the electrode coating is being dissipated too rapidly owing to abnormal operating conditions which may be due to one or more of the following causes:—

(i) overloading due to incorrect choke or choke tapping being employed;

(ii) defective starting switch causing lamp to blink on and off, or prolonged flashing at starting;

(iii) overloading caused by defect in the choke coil.

In these cases the choke and choke tappings and average mains voltage should be carefully checked and, if necessary, the starting switch replaced. A fault in the choke coil is extremely rare, but when it does occur it is sometimes not easily traceable by visual inspection. A serious fault may give rise to burnt insulation or, in the case of wax-filled chokes, seepage of the wax through the metal container.

In conclusion it will be appreciated

that whilst the maintenance of a fluorescent lamp installation is not quite such a simple matter as that of a tungsten filament lamp installation, a study of the subject will more than be repaid. This is especially true when the advantages in efficiency and colour of fluorescent lighting are taken into consideration.

This article has described in some detail the faults that might arise in fluorescent tube installations, their probable causes, the symptoms by which each fault may be recognised, and suggestions for rectification of these faults. It must be clearly emphasised, however, that lighting failures will not occur more frequently with fluorescent lamps than the failures that occur with the more familiar tungsten filament lamps. The important point to notice is that with tungsten lamps there is usually only one cure, whereas with fluorescent lamps the cure may be any one of several.

Church Lighting

In an address recently delivered to the I.E.S, Birmingham Centre, Mr. W. P. Watson dealt with "church lighting"—a subject on which many different opinions are held.

Mr. Watson contended that the chief object in lighting a church should be the creation of a pleasing atmosphere—an atmosphere such as invited visitors to return to the church—and the revealing of the architectural beauty of the interior. He could not subscribe to the view held by some authorities that the upper part of the nave of a church should be left in comparative darkness, a condition which was certain to have a depressing and possibly an irritating effect on members of the congregation.

Mr. Watson reviewed the standards of illumination required in various parts of a church and in churches of different denominations. In general he advocated 5-7 lumens per sq. ft. where direct lighting from pendants was used and 6-8 lumens per sq. ft. where concealed lighting was adopted. In the chancel a somewhat higher value of illumination, say 8-10 lumens per sq. ft., should be provided.

Great importance attaches to the location, mounting height, and nature of pendant lights, and their relation to church architecture, which Mr. Watson discussed in some detail. In particular every care should be taken to avoid extreme contrasts between the brightness of sources and their background.

In the latter part of his lecture, Mr. Watson devoted special attention to concealed lighting, the adoption of which in churches may require considerable care and skill. One objection sometimes raised by church authorities is the difficulty of maintenance. Contractors, therefore, should, in their own interest, establish a maintenance service for such schemes.

Built-in fittings, Mr. Watson suggested, could often be contrived to blend well with the architectural scheme. Fluorescent lighting, though little applied to churches as yet, had possibilities, more especially for the treatment of chancels and altars, where projectors housing filament lamps might be difficult to instal.

"Light and Colour"

As we go to Press we receive a copy of the latest E.L.M.A. leaflet—the first ever produced dealing with colour as an integral part of the lighting scheme. The leaflet is excellently got up. The earlier portion deals with the spectrum and the nature of colour and its perception by the eye. Subsequently, in a section entitled: "Light and Colour in Industry," some very effective coloured pictures show how attractive even industrial interiors thus treated may be. The colouring in harmonious tints of walls, fittings, and machinery makes a pleasant impression, and the marking out, in distinctive hues, of such objects as switches, press buttons, control handles and safety guards in distinctive colours is most valuable from the safety standpoint.

Human Factors In Industry

An account of a recent Conference arranged by the British Association at which lighting in factories and coal mines was discussed.

A conference arranged by the British Association for the Advancement of Science took place at Leamington Spa on Saturday, May 8, when two of the opening speakers dealt with lighting. The conference was well attended, and among the audience were Mr. Howard Long, a well-known past vice-president of the I.E.S., and Professor G. P. Crowden, an honorary member of the Society. The first session, under the chairmanship of Sir Henry Tizard, K.C.B., F.R.S., who is president of the British Association, and chairman of the Advisory Council on Scientific Policy, was devoted to the discussion of working conditions. Sir George Schuster, K.C.M.G., C.B.E., chairman of the Industrial Productivity Committee's Panel on Human Factors, presided at the second session, when Human Relations in Industry were discussed.

In the first session Professor R. E. Lane, F.R.C.P., of Manchester University, briefly surveyed the subject of working conditions from the point of view of the industrial medical officer. He pointed out that the first contribution the doctor can make to the betterment of occupational health and efficiency is to exert an educative influence. There is a vast amount of information available on human industrial problems which is not used, because industry is ignorant rather than wilfully neglectful of it. The results of much research work need to be interpreted to industry before particular applications can be attempted, but one of our greatest immediate needs is that well established results concerning the effects of environmental conditions should be made more widely known. One of the most important functions of the industrial doctor should be to spread this knowledge, while his other work is to see that the worker is fit for the job and that the job is fit for the worker.

Lighting in Coal Mines

Dr. C. L. Cope, F.R.C.P., who is Director of Research into Human Problems to the National Coal Board, followed Professor Lane with a paper dealing with some of the problems of health in the mining industry. Naturally, his paper was much concerned with conditions of lighting and the visual disabilities to which miners are liable. He mentioned that the number of cap lamps in use in mines is rising steadily, and the efficiency of these lamps is being improved. The number of cap lamps has risen from 1 per 100 men in 1928 to 34 per 100 in 1946 and is still going up.

Recently it has become possible to install fluorescent lighting not only in the haulage ways but also at the coal face, and this is a very great advance. At present the experimental installations operated from the mains seem to be more satisfactory than those in which pneumatically operated lighting units are used. In general the reception accorded to this method of lighting has been extremely good. Rapid extension of the installations is to be hoped for, though the main difficulty is the cost. It would be of the greatest value to know what effect such lighting has on nystagmus development and accident rates. As yet the number of men affected by such lighting is very small, but by collecting accident records from all the fluorescent lit coal faces through the country and comparing the results with suitable controls it is expected that some indication of trends will be detectable in about a year.

It has recently been shown that miners working underground develop an impaired dark adaptation, whether they have nystagmus or not. Its cause is not known, nor is its rapidity of onset, but it is not thought to be associated with deficiency of Vitamin A. Underground workers also get an impairment of binocular vision, and of this again neither the cause nor the rate of onset is known. But these changes offer a hope that the effects of various types of lighting may be ascertained much sooner than would be possible if the end results of actual nystagmus had to be waited for.

Factory Lighting

Mr. H. C. Weston, whose contribution dealt with lighting in industry generally, stressed the point that conditions of lighting in factories must satisfy two fundamental needs of the workers; first, the need for a sufficiently bright environment to promote cheerfulness, alertness, and the feeling of invigoration that finds its natural expression in mental and physical activity, and secondly, the need to see all the essential details of the actual work-objects quickly and confidently, and at a comfortable viewing distance. It does not follow that conditions which satisfy the first of these needs will also satisfy the second, and vice versa, though in some circumstances this may be so. But it is quite possible to have good general lighting of a factory and unsatisfactory illumination of the work, or good illumination of the work and quite unsatisfactory environmental brightness. Where the latter prevailed, the depressing effect had earned for the factories such expressive epithets as "the dump."

Among the conditions of lighting which promote general well-being and good productivity, a sufficiency of illumination is unquestionably the most important, though, of course, there must also be a proper distribution of light, while glare and harmful shadows must be prevented. During the past 30 years, much has been done to establish what levels of illumination are necessary for the comfortable and efficient performance of different industrial tasks, and also to determine other desirable conditions of lighting. The results of all this work have been codified by the I.E.S., and, since visual capacity varies over a very wide range of illumination intensities, the I.E.S. Code necessarily recommends widely different levels for different processes, because some industrial tasks make the least while others make the greatest demands upon visual capacity.

Mr. Weston showed a number of slides illustrating the effect of illumination upon industrial performance. He also dealt very briefly with natural lighting, and with the "naturalisation" of artificial lighting when it has to be used continuously, or for long periods, to make good a deficiency of daylight. He said there is no evidence that the commonly used artificial illuminants, including "fluorescent light," are harmful to the eyes, and that many people who complain about artificial lighting do not discriminate between the illuminant and other characteristics of the lighting. It is these other characteristics which are often blameworthy if an installation is unskilfully designed. Finally, he said, the changing age distribution of the industrial population should be taken into account in planning the lighting of new factories and the relighting of existing buildings.

Lighting and Ophthalmologists

In his presidential address to the Ophthalmological Society of New Zealand, Dr. W. A. Fairclough, who is a member of the I.E.S., said that he had chosen the subject of industrial lighting as he felt that the importance of illumination was not sufficiently appreciated by ophthalmologists as a body. It was a subject, he said, which their profession should develop so that they could with authority advise on lighting problems.

He reviewed the work which had been done to provide comfortable and suitable lighting in industry, and after dealing with the physiology of vision, went on to discuss symptoms of eye strain. Headaches, fatigue and all the accompanying disabilities resulting from eye strain stress the importance of providing proper illumination and all other conditions calculated to lessen asthenopia among "eye workers." Most symptoms of eye strain are intensified by poor lighting, and many eye conditions are relieved by correct illumination. It is, he said, usually the distribution of light, rather than the wavelength, that is at fault. Though ample diffuse lighting is the approved type, public opinion has not in general advanced beyond the idea of a "good light over the left shoulder."

The present great improvement in the lighting of modern buildings, he said, is chiefly due to the work of the various illuminating engineering societies. Sir John Parsons, in England, has made most valuable contributions to this subject, on the whole, ophthalmologists and physiologists have for some reason taken only a minor part in the developments in this important aspect of modern life.

Foot-Candle Levels

(*Contributed*)

In a recent issue of *Illuminating Engineering* (April, 1948, p. 395) there appears the paper on the above subject, read by Dr. M. Luckiesh at the National Technical Conference held in New Orleans last year, and the contribution to the discussion (the only one apparently) by Mr. J. M. Waldram.

In Mr. Waldram's contribution, to which we have referred previously in general terms, there are several points of outstanding interest.

We Cannot Measure Sensation

The first of these is the statement of Dr. Luckiesh, which Mr. Waldram fully endorsed, that "rates of work" and like measures "do not indicate what the eye and visual system have to undergo," and to this extent only imperfectly illustrate the advantages of better lighting. We can measure apparent results but we cannot measure sensations. We can, with some success, estimate the illumination below which some given task can only just be done, but we cannot assess the greater ease with which the same task is executed as the illumination is increased beyond this limit. A comparatively simple task may be done with apparent perfection by a moderate illumination. If now the illumination is increased and the lighting improved there may be no perceptible (and even no possible) improvement in performance. Nevertheless, the task may be done with greater ease and comfort, and it is just this factor which is so difficult to measure.

One complication in connection with all such tests is the capacity for temporary increased effort, which often enables people to accomplish, under disadvantageous conditions, more than they would naturally do. Such an effort cannot be sustained but may completely upset results in tests over a relatively short period. In this connection Mr. Waldram recalled some experiments in the Psychological Laboratory at Cambridge, where subjects working by very bad conditions in a flickering light actually performed slightly better than they did by normal illumination.

Near Vision and Short Sight

Mr. Waldram, however, disagreed with the suggestion that the fact of children reading "comics" holding the text closer to the eyes than they should may cause short-sightedness. He quoted authorities to the effect that the muscles and structure of the eye are of the same kind as the muscles and structure of any other part of the body. If they are overworked they may be fatigued and may need rest, but they recover normally and are not *changed*.

"If I run upstairs," said Mr. Waldram, "my legs may be tired and I shall perhaps sit down to recuperate, but my legs will not be any shorter." He disbelieved the impression that children become short-sighted as a result of such action—that because they sometimes hold reading matter closer to the eyes than normal they will be unable to see properly objects at a distance. "Surely this is most unlikely; it is rather like suggesting that if I run upstairs too fast I shall be unable to get right downstairs again."

This mode of "argument by analogy," if highly effective, is a little dangerous—one can never be quite sure that the two things compared are, in essence, identical. But there can be little doubt that we *should* be very cautious in making statements about alleged deterioration in vision caused by inadequate lighting, which, if it does exist, is most difficult to prove.

The "Compensating" Effects of High Illuminations

Another argument for very high illumination, based on "compensation," was also criticised. It is doubtless true—as is, indeed, evident in the working basis of the I.E.S. Code—that handicaps to good visibility can be partially countered by increasing the illumination. But the rise in illumination to achieve even a small improvement may be so high as to prove prohibitive and, not infrequently, the improvement can best be gained by quite other means. A familiar case in point is furnished by processes involving very close work, where it has been shown that special magnifying glasses are much more potent in relieving the visual effort than any increase in illumination is likely to be. Again, in circumstances where the contrast between object and its immediate background is small, increasing the illumination to a high level does aid visibility. But it may be ever so much better to effect the improvement by securing better contrast between

object and background. Of recent years the desirability of the illuminating engineer interesting himself in the decoration as well as the lighting of interiors has been often emphasised. It may well also be argued that he should take a hand whenever any of the factors contributing to clear vision, such as conditions of contrast, are involved.

The Evolution of the Eye

Finally, there is the oft-quoted argument that the eye has evolved by natural light—daylight—and can therefore only be satisfied by illuminations such as one finds out of doors on a bright summer day. It is important to realise, as Mr. Waldram pointed out, that the evolution of the eye has been influenced by night as well as day, that daylight is immensely variable both in quality and in intensity, and that the most obvious feature of the eye is its marvellous power of adapting itself to extreme variations in brightness.

Lighting and Industrial Medicine

It is interesting to note that lighting is one of the subjects which will be considered by the Ninth International Congress on Industrial Medicine, which is to be held, under the patronage of Their Majesties the King and Queen, at the Caxton Hall, London, from September 13 to 17. This is the first congress of its kind to be held in Great Britain. The scope of industrial medicine covers a wide range of subjects, and these are grouped for consderation in six sections. Section B is concerned with the environment of the worker, and the programme provides for seven sessions of this section, in one of which a paper on Illumination and the Visual Task is to be given by Mr. H. C. Weston. One of the sessions of Section D is to be devoted to Industrial Ophthalmology, while sessions of Section S will be concerned with the application of industrial legislation, and with radiant energy hazards and their prevention. The programme is a very full and comprehensive one, for it is 10 years since the Eighth Congress was held, and much knowledge has been gained during this period.

Difficulty of the Aged in the Dark

Many of us in our childhood were more or less afraid of the dark, and it seems that fear of the dark often comes again at the other end of life, though generally for a different reason. Dr. J. H. Sheldon, whose report on the Social Medicine of Old Age has recently been published for the trustees of the Nuffield Foundation, points out that it is well known that old people are not so indifferent to going out in the dark as are the young, and he inquired into the reasons underlying this disability on 118 persons, whose ages ranged between 65 and 80 years.

Twenty-one of these subjects said they could not see in the dark, and Dr. Sheldon thinks they probably had true night-blindness, presumably of senile origin. Twenty-one others said they felt unsafe in the dark, and a common remark was that they could not see where they were putting their feet. Others said they lost all sense of direction in the dark.

On the whole, the case-reports lead Dr. Sheldon to suggest that, in most instances where old people have difficulty in coping with the dark, the reason lies in a senile failure of the mechanisms subserving posture and orientation in which the labyrinth (the balancing organ associated with the inner ear) plays a very important part. When deprived of accessory sources of information as to the position of the body in spaces—i.e., the eyes and, when available, the sense of touch—the labyrinth of these old people is unequal to the task of controlling their posture and position. Support for this hypothesis is afforded by the incidence of vertigo among old people. In the subjects studied Dr. Sheldon found 20 per cent. of men aged 65-69 who had difficulty in the dark, and 27.6 per cent. who were liable to vertigo. For the age group 75-79 the corresponding percentages were 52.3 and 62. In women of these two age groups the figures were 54.5 per cent. and 52.8 per cent for the first group, and 50 per cent. and 64.7 per cent. for the older group. The old, therefore, depend more upon vision to give them confidence and stability in movement than the young, yet, of course, their vision is not so good.

The Trotter Memorial Lecture

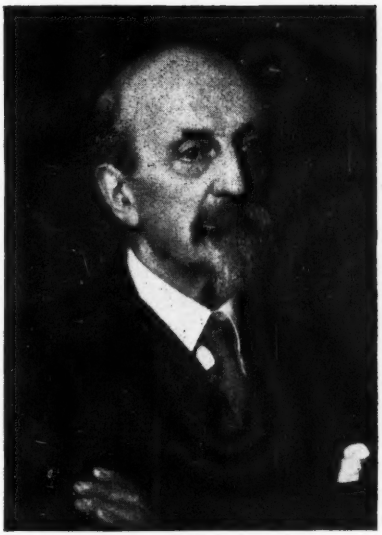
The Council of the Illuminating Engineering Society has decided to establish a special lecture, to be known as "The Trotter Memorial Lecture," in memory of Mr. Alexander Pelham Trotter, who passed away last year.

It is proposed that the lectures will be delivered at intervals of one to two years, the first four lectures to be delivered in 1948-49, 1950, 1951-52, and 1953. The lecturers will be chosen by the I.E.S. Council. Lectures will be open to the public by ticket of admission and without charge, and will be widely advertised. They will in general be published by the Society.

The cost of meetings and publication will be met by the Society out of general income.

It is, however, proposed to form **a special fund,** to be known as "The Trotter Memorial Fund," which will be held in trust by the I.E.S. and administered by its Council. The interest on this fund will be utilised to furnish appropriate fees for the lecturers, which it is hoped will be at least £25 on the occasion of each of the first four lectures.

It has been suggested that members of the Society, more especially those who have personal recollection of the great services rendered to the Society by Mr. Trotter, would welcome the opportunity now afforded of subscribing to this fund, of which their donations will form the nucleus. Those desiring to contribute are requested to make use of the detachable form, which will be found below.



Alexander Pelham Trotter
(I.E.S. President: 1917—1920)

HISTORICAL NOTE

Alexander Pelham Trotter was born on June 25, 1857, and died at the age of 91, on July 23, 1947. He was educated at Harrow and under Clerk Maxwell at Cambridge, and for a time was

PLEASE CUT HERE

THE TROTTER MEMORIAL LECTURE FUND

TO: *The Honorary Treasurer,*
The Illuminating Engineering Society,
32, Victoria Street, London, S.W.1.

I enclose a { * **cheque** / **postal order** / **money order** } for £ s. d.

as a contribution to the fund for the Trotter Memorial Lecture.

Signature .....

Address .....

.....

Date.....

* Strike out words not required

Research Assistant to Silvanus P. Thompson at Finsbury Technical College.

After early experience in dynamo manufacture he became editor of "The Electrician," served as Government electrical engineer for the Cape of Good Hope, became electrical adviser to the Board of Trade and after retirement joined the firm of Handcock and Dykes, consulting engineers.

He was a member of several learned and technical societies, and he served them with distinction. In 1892 he was awarded the Telford Medal of the Institute of Civil Engineers for his paper entitled "The Distribution of, and Measurement of, Illumination," which served as a basis for a major text book which is still a classic. This was followed in 1929 by a smaller book, "The Elements of Illuminating Engineering." He was the Faraday lecturer of the I.E.E. in 1926.

In 1914, Mr. Trotter advised on wartime street lighting, making observations from a balloon for the purpose, and he was chairman of the I.E.S. Committee, which conducted experiments on parachute flares (shell-flares) for the Department of Trench Warfare. The "Alphabetical Column" photometer was developed at this time for measurement of rapidly changing illumination.

Mr. Trotter was a member of this Society from its foundation until his death. In 1917 he became president, and continued in office for three years. He was chairman of the Joint Committee on Illuminating Engineering appointed by the Department of Scientific and Industrial Research in 1917, and, when the war was over, he led a deputation which paved the way for the Committee on Illumination Research. He was elected an honorary member of the Society in 1941.

Mr. Trotter was skilled with his hands, and was always keen to try out for himself any new inventions or techniques in which he was interested. He made a pair of telephone receivers in Cambridge in 1877 (the same year as Graham Bell's published account) and obtained clear, though faint, speech across the quadrangle of Trinity College. Many years later, he was in the forefront of wireless experimentalists, and after his retirement to Teffont, near Salisbury, he enjoyed woodworking, printing, and bookbinding.

Mr. Trotter's contributions to *The Illuminating Engineer* were of great value. His work on public lighting, on photometry, on standards of light, on the control of light by prisms, and on natural lighting, was all of a fundamental nature and laid the foundations on which others have built. His value to this Society in the early days was enhanced alike by his high scientific reputation, by the independent position he occupied, and by his unique personal disposition. He combined a natural dignity with an unaffected simplicity, courtesy, and kindness of heart which won the esteem of all with whom he came in contact. He was a great figure in the field of illuminating engineering and his is a name which we may fittingly remember by a memorial lecture on pioneer work.

Fluorescent Street Lighting in Wolverhampton

Fluorescent lighting—rather contrary to early expectations—is evidently proving highly popular for street lighting. Yet another effective example is furnished by the installation in Wolverhampton, illustrated above, which utilise two 5-ft. 80-w. "warm white" fluorescent lamps in each lantern.

The lanterns are of the "Sol-Etern" pattern manufactured by Revo Electric, Ltd., and are mounted on existing trolley-bus standards at a height of 25 ft. A feature of interest is the use of supporting brackets which enable the lanterns to be swivelled, thus facilitating lamp replacements and cleaning.

As will be gathered from the picture the visibility is extremely good and the absence of glare and apparent even brightness make a very favourable impression. It is stated that anyone standing in the street can read a newspaper by the artificial lighting with ease, and in any part of the installation.

A point of interest is the selection of lamps of a "warm white" type and there seems ground for thinking that in busy urban streets this may often be preferred to the colder "daylight" effect.

"Glass Bulbs, Ltd."

The registration of a new company under the above title, with an authorised capital of £1,000,000, is of considerable interest. The capital is subscribed equally by two lamp companies, the B.T.H. and the G.E.C., which, owing to the interruption in the supply of bulbs from abroad since 1940, have had difficulty in keeping pace with the growing demand for their products.

It is hoped that this new special purpose factory will produce bulbs more economically and will permit the development of a considerable export trade in bulbs in addition to lamps. A site for the factory has been chosen at Harworth, near Doncaster, where eventually a potential capacity of 400,000,000 bulbs per annum should be attained. Present inevitable delays in building premises and installing machines may, however, prevent the start of production until the end of 1949.

Lighting for Table Tennis

Notes on a Report of a Joint Committee representing the Illuminating Engineering Society (U.S.A.) and the United States Table Tennis Association (*Illuminating Engineering*, March, 1948).

There is one factor that may sometimes have an important influence in determining requisite illumination, though there have hitherto been few data available thereon—i.e., *speed of vision*. Probably the best example of its operation is afforded by various fast ball games such as table tennis.

The order of illumination in such cases is settled primarily by the needs of players, but in the case of exhibition play the impressions of spectators, who prefer the higher levels of illumination, and especially when the play is watched from some little distance, should also be taken into consideration.

The report contains a chart showing the relative visibility of the table tennis ball at points throughout its trajectory as seen by the player, determined by the aid of a Luckiesh-Moss visibility meter. The improvement in visibility as the illumination was increased from 5 to 110 ft.c. is evident. Confirmation is afforded by records of the "per cent. of possible score," "per cent. of returns deep and centre," and "per cent. of returns missing table." These show a steady improvement in performance with increasing illumination, which persists even after 50 ft.c. is attained—and a very evident deterioration when the illumination falls below 20 ft.c.

Views of various installations, both with filament and fluorescent lamps, are shown. In all cases stress is laid on the screening of lights and the avoidance of anything in the nature of glare. Fluorescent lamps recessed in the ceiling afford very favourable conditions.

An important distinction is drawn between recreational and exhibition play. For the latter, more stringent conditions are suggested, not only in regard to values of illumination provided but also the area illuminated — illumination of the space at the back of the table becoming correspondingly more important as the standard of skill rises. For recreational play, two deep, conical metal shades with 150-watt inside-frosted filament lamps will answer. Satisfactory conditions may also be attained by the use of two fluorescent lamp fittings arranged either crossways or lengthwise with respect to the table. An installation recommended for skilled play utilises five recessed troughs each with two 40-watt fluorescent lamps end-to-end.

A very interesting question, in view of the rapid movements of the table tennis ball, is the possibility of stroboscopic effect with fluorescent lamps. At relatively low levels of illumination annoying flicker has been reported, even though two-lamp "lag and lead" units were used. At 55 and 110 ft.c., however, no stroboscopic effect was observed — the effect becoming progressively less evident as the illumination advances.

In the recommendations of the Committee, the playing area for skilled play is assumed to extend at least 2 ft. on each side of the table and at least 11 ft. at the back of each end of the table—thus requiring a minimum area 9 ft. wide and 31 ft. long, all of which should be adequately lighted.

For recreational play, as in most home recreation rooms, where space is limited, the table may be considered the playing area.

The values of illumination recommended are:—

Tournaments	50 ft.c.
Clubs	30 „
Recreational (homes)	20 „

The lowest value of illumination should be not less than 50 per cent. and preferably not less than 75 per cent. of the average value. These are "service" values—i.e., initial values should be high enough to allow for normal deterioration.

The recommended average illumination over non-playing areas, including spectator areas, is 5 ft.c. (approx.).

Sufficient light should be directed to the ceiling and upper side walls to avoid sharp contrasts in brightness and to give the room a cheerful appearance. Light sources should be screened from the eyes of players and spectators at all usual viewing angles. The lower side-walls should be finished in medium tone (ref. factor 20-40 per cent.) and the upper side-walls and ceiling in a light tone (ref. factor at least 60 per cent.).

The EDITOR Replies

The remarks in the last issue on the *influence of fluorescent lighting on the appearance of coloured objects* and, in particular, people's complexions, has brought me a letter from Mr. R. Nagel, who is associated with the Industrial Colour Advisory Department of Ferguson Edwards, Ltd. He draws attention to a recent research in America on this subject ("Colour Characteristics of Human Complexions," Illuminating Engineering, January, 1948, p. 27) in which the problem was studied very thoroughly. (Actually over 100 persons of all races, ranging from dark brunettes to near-albino blonds were studied and spectrophotometric curves made of their facial skin.)

Mr. Nagel remarks that these experiments seem to confirm the desirability of fluorescent tubes which are intermediate in colour between daylight and warm white. For the *best appearance of human complexions*, however, a colour intermediate between warm white and tungsten is suggested—though if the test were confined to people in northern latitudes only the result would surely be different from that derived from tests of people of all the chief races of the world.

It is to be noted, however, as remarked in the last issue, that fidelity in appearance of colours may not be the only or even the main criterion. The dominant consideration may be that people, flowers, and foodstuffs should "look their best"—a somewhat indefinite requirement.

Dealing with colours in general, Mr. Nagel indicates another way of approaching the problem—the choice of paint to suit the illuminant rather than the choice of the illuminant to suit the paint. Thus, in industrial interiors, it has been found better to choose a paint that is made slightly brighter by artificial light rather than duller; or, alternatively, to select an illuminant that slightly distorts the colours in the same direction.

Consideration of the *response of the eye to changing values of illumination* (which Mr. P. J. Waldram was disposed to consider beneficial) was another matter discussed in our last issue. This question is linked up with the idea of windowless rooms, lighted solely by artificial means and to a high degree of uniformity. Mr. H. C. Cooper, however, has written to me suggesting that there is another factor in such cases—*the distance on which the eye is focussed*. He has found, for instance, in his experience that the use of obscured glass has a bad effect—even though it admits daylight. He infers that the eye suffers (or possibly is merely bored?) when its range of focus is confined to a few feet, instead of ranging over near and distant objects as occurs out of doors. If so, here is

another argument against the windowless factory.

Mr. R. F. Truman writes on the subject of the *lighting at the British Industries Fair*. Too frequently, he remarks, exhibits were illuminated by lamps in shallow opal shades exposing the lamps to view—and some of the pendants seemed to date from the Victorian era! In some instances the source of light was actually immediately behind the object exhibited. This is an old complaint in connection with exhibitions. It is odd that when so much trouble and expense is lavished on the stands of exhibitors so little effort is made to ensure that they are properly lighted. Is this a field in which the influence of the I.E.S. might well be exerted—for example, in connection with the important Centenary Exhibition, planned to take place in 1951?

I.E.S. members will be interested to learn that *Mr. R. A. Eshelby* is now located in *Montreal*. I am asked to mention that he will be happy to get into touch with any I.E.S. members or friends in the lighting industry contemplating a visit to that city. His address is 6, Third Avenue, Greenfield Park, Montreal. (Tel. No. Wilbank 4181, Local 207.)

SITUATION VACANT

A LARGE ORGANISATION in the Midlands engaged on the production of road vehicle lighting equipment has a vacancy for an illuminating engineer. The duties include design and development, control of production quality and liaison with suppliers. The situation is permanent and offers excellent prospects. Applicants should be of degree standard and should have practical illuminating engineering experience. State age, qualifications, and experience. Box 778, "Light and Lighting," 32, Victoria-street, S.W.1.

Lower Prices for Fluorescent Lamps

E.L.M.A. members recently announced important reductions in the prices of fluorescent lamps, which took effect on June 1. The 5-ft. 80-w. lamp is reduced from 20s. to 15s. 6d., and the 4-ft. 40-w. from 16s. 6d. to 14s., with corresponding reduction in purchase tax. In addition, the marketing of two new sizes, from July 1 onwards, comes into effect on July 1. Of these the 2-ft. 40-w. lamp is to be listed at 13s. in place of 14s.

Dr. Hampton, B.Sc., Ph.D., F.R.I.C., F.Inst.P., F.I.E.S, F.S.G.T., of Messrs. Chance Brothers, Ltd., was recently elected as President of the Society of Glass Technology for the session 1948-1949. Mr. Geoffrey Marchand, Director of the Glass Manufacturers' Federation, is the outgoing President.

Retirement of Mr. W. W. Willmott

At a dinner held at the Trocadero Restaurant, London, on Friday, May 21, to mark the retirement of Mr. W. W. Willmott as publicity manager of

Siemens' Electric Lamps and Supplies, Ltd. (a post which he has held for 25 years), a presentation of a solid silver fruit dish was made by Mr. R. E. Hesketh (G.E.C.), on behalf of the E.L.M.A. Publicity Committee. (See photo.)

Mr. Willmott is well known in the lighting industry, and in retirement will carry with him the good wishes of many firm friends.

Street Lighting In London

A fluorescent street lighting installation which is the largest in London, and also the first instance of existing columns being converted for this form of lighting, has just been completed by the G.E.C. It comprises 17 units, each of two lanterns, and extends along nearly half a mile of Marylebone Road.

The "Four-Eighty" lanterns are an improved version of those installed in Kingsway and each houses four 5-ft. 80-watt warm-white fluorescent lamps. Each pair of lanterns is mounted on a specially designed column head, the whole being mounted at 25 ft. on existing steel columns in the centre of the carriageway. (See photographs on this page.) Spacing is approximately 150 ft.

Auxiliaries are housed in the base of the columns. The four lamps in each lantern, two on each side, are arranged so that the bottom two can be switched off for half-night lighting, and twin-lamp circuit is employed to give unity power factor for full or half-night lighting. The lanterns used can also be supplied for spanwire suspension.

Tungsten and Fluorescent Lighting

In many successful installations nowadays both tungsten and fluorescent lighting are utilised. An instance is afforded at the Beaufort House premises of the Anglo-Iranian Oil Co., Ltd. Tungsten lighting is used for the six office floors, averaging about 10,000 sq. ft. each, whilst in the basement, where the staff canteen is located, fluorescent lighting has been installed. In the complete installation nearly 1,000 tungsten lamps and about 150 fluorescent lamps are used.

Fig. 1. A typical office floor with tungsten lighting.

On the office floors (Fig. 1) 200w. tungsten lamps in Holophane "Correctalite" glassware are used, furnishing 15 lumens per sq. ft. The fluorescent lamps in the canteen (Fig. 2) are mounted in Sieray fittings with perspex reflectors, to yield a soft warm illumination of 7 lumens per sq. ft.

Fig. 2. Part of the staff canteen in which fluorescent lighting is installed.

The installation was planned by the Illuminating Engineering Dept. of Siemens Electric Lamps and Supplies, Ltd., who supplied the lamps and fittings for both tungsten and fluorescent lighting.

Vital Colour

Under this title a vivid brochure has recently been issued by Lewis Berger and Sons, Ltd. By the aid of numerous effective colour prints the fundamental phenomena of colour vision are illustrated. The Munsell colour tree and the nature of the spectra from different light sources are shown, and the distinction between additive and subtractive colour mixtures is pictured.

Subsequently, under the heading "The Application of Colour," there is a series of pleasing illustrations, showing colour effects, not only in domestic interiors but in schools, offices, factories, restaurants, etc.